

PATENT COOPERATION TREATY—

PCT

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

EGBERT, John, S.
7th Floor
412 Main Street
Houston, TX 77002
ETATS-UNIS D'AMERIQUE

Date of mailing (day/month/year) 17 September 2001 (17.09.01)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference	
International application No. PCT/US00/27357	International filing date (day/month/year) 04 October 2000 (04.10.00)

1. The following indications appeared on record concerning:

☐ the applicant ☐ the inventor ☒ the agent ☐ the common representative

Name and Address EGBERT, John, S. Harrison & Egbert Suite 100 1018 Preston Street Houston, TX 77002 United States of America	State of Nationality	State of Residence
	Telephone No. 713 223 4034	
	Facsimile No. 713 223 4873	
	Teleprinter No.	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☐ the name ☒ the address ☐ the nationality ☐ the residence

Name and Address EGBERT, John, S. 7th Floor 412 Main Street Houston, TX 77002 United States of America	State of Nationality	State of Residence
	Telephone No. 713 224 8080	
	Facsimile No. 713 223 4873	
	Teleprinter No.	

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned
<input checked="" type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Idhir BRITEL Telephone No.: (41-22) 338.83.38
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PATENT COOPERATION TREATY

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NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
 US Department of Commerce
 United States Patent and Trademark
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 2011 South Clark Place Room
 CP2/5C24
 Arlington, VA 22202
 ETATS-UNIS D'AMERIQUE
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Applicant SOMERVILLE, Robin, B. et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:
 16 April 2001 (16.04.01)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
 34, chemin des Colombettes
 1211 Geneva 20, Switzerland

Facsimile No.: (41-22) 740.14.35

Authorized officer

Olivia TEFY

Telephone No.: (41-22) 338.83.38

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- (71) Applicants and
- (72) Inventors: SOMERVILLE, Robin, B. [US/US]; 2517 Ninth Street, Port Neches, TX 77651 (US). FAN, Liang-
- (74) Agent: EGBERT, John, S.: Harrison & Egbert, Suite 100, 1018 Preston Street, Houston, TX 77002 (US).
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WO 01/25373 A1

(54) Title: PROCESS FOR MODIFYING COAL SO AS TO REDUCE SULFUR EMISSIONS

(57) Abstract: A method of manufacturing a coal product having reduced sulfur emissions including the steps of grinding coal into a powder form having a desired particle size; blending the ground coal with hydrated lime; adding water to the blend so as to have a moisture content of between 10 and 30 weight percent and drying the water-added blend so as to have a desired reduced moisture content. The desired reduced moisture content is less than 1 % of the total weight of the coal powder and the hydrated lime. The step of drying includes heating the water-added blend to a temperature of between 300 and 400 °F in an externally heated oven. Waste heat from a power plant can be used so as to heat the blend.

PROCESS FOR MODIFYING COAL SO AS TO REDUCE SULFUR EMISSIONS

TECHNICAL FIELD

The present invention relates to coal desulfurization. More particularly, the present invention relates to methods and processes by which the resultant emissions of sulfur from coal burning operations are reduced. The present invention also relates to the manufacture of coal treated with fresh hydrated lime.

BACKGROUND ART

Electric-power plants fired by coal or oil emit sulfur oxides, nitrogen oxides, and particulates. In industrialized countries, such plants account for up to 75% of the total of sulfur oxides, and, since the electric-power industry is rapidly proliferating, the potential increase of sulfur-oxide emissions is tremendous.

A number of measures have been adopted in an effort to control sulfur-oxide pollution. However, a number of technical problems stand in the way. In many existing power plants, low-sulfur coal cannot be burned without operational difficulties or without incurring high capital costs for furnace modifications. Sulfur can be removed from coal before burning, but the procedure is costly. The content can be cut in half by pulverizing the coal to the consistency of talcum powder and removing the pyrites (sulfur compounds) or by one-third by washing the coal and removing noncarbonaceous material. However, even with as much as 70% of the sulfur removed, the final coal product might still be classified as a high-sulfur fuel.

Several methods of removing sulfur from stack gases have been considered and utilized. In one technique, pulverized limestone or dolomite is added to the boiler charge, creating oxides that react with the sulfur oxides to form solid sulfite and sulfate particles that can be removed by electrostatic precipitation. In another process, catalytic conversion, the sulfur dioxide is converted to sulfur trioxide, which combines with water in the stack gas to form a sulfuric acid mist that can be trapped and eliminated. Another method is to produce sulfuric acid, which can be readily removed from the stack gas by the addition of an activated char, a carbonaceous material.

In most uses, the sulfur content of coal is objectionable in varying degrees. Part of the sulfur is associated with ash, and coal washing removes some sulfur along with the ash. Much sulfur, however, is more intimately associated with the coal substance itself and cannot be removed by washing. Since carbonization removes some sulfur, coke usually contains a lower percentage of sulfur than the coal from which it is made. During total gasification, most of the sulfur is converted into hydrogen sulfide, the form in which it can be readily separated from the gas. Extraction of coal

with solvents produces an extract of relatively low sulfur content. Despite the use of these methods and considerable effort, no effective method has been devised to reduce the sulfur content substantially, particularly the portion closely associated with the coal substance.

It is an object of the present invention to reduce sulfur emissions from the combustion of high-sulfur coal.

It is a further object of the present invention to provide a process that reduces the ash from the combusted coal.

It is a further object of the present invention to provide a process that lowers the pH of the ash of the combusted coal.

It is still a further object of the present invention to provide a process for reducing sulfur emissions in an economic, efficient and easy-to-use operation.

These and other objects and advantages of the present invention will become apparent from a reading of the attached specification.

SUMMARY OF THE INVENTION

The present invention is a process for manufacturing modified coal so as to reduce sulfur emissions. This process comprises the steps of: (1) grinding the coal to a powder of a desired consistency and particle size; (2) blending the ground coal with fresh hydrated lime $[\text{Ca}(\text{OH})_2]$; (3) adding water to the blended coal/hydrated lime mixture so as to maintain a moisture content of between 10 and 30% of the overall weight; and (4) drying the agglomerated coal/hydrated lime mixture so as to have a moisture content of a desired level.

In the process of the present invention, the coal is ground to a size of between 80 and 20 meshes (180 micrometers to 850 micrometers). Ideally, the average size of the ground coal particle will be 40 meshes (425 micrometers). Within the concept of the present invention, the coal which is ground is a high-sulfur coal. The fresh hydrated lime is in a powder form. Ideally, the particles of the powder form of the hydrated lime should be less than 10% of the size of the coal particles. The amount of hydrated lime which is added to the ground coal particles will depend upon the sulfur content of the coal. Generally, the amount of fresh hydrated lime will be 1 to 15% of the weight of the coal.

Water is added to the blended mixture of the hydrated lime and ground coal so as to achieve an intimate agglomeration. Finally, the agglomeration is dried so that the moisture content is approximately 1%. The drying can be accomplished by using externally heated dryers or ovens.

The mixture of the water, hydrated lime, and ground coal is heated to a temperature of between 300 and 400°F. The heat for such dryers can be provided by the waste heat of a power plant. The heat can also be provided by a preheater prior to passing the treated coal to the boiler.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a schematic illustration of the process of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIGURE 1, there is shown at 10 a schematic representation of the process of the present invention. In the present invention, a coal supply 12 is available for the delivery of coal to a grinder 14. The coal supply 12 can be of a high-sulfur coal. The grinder receives the high-sulfur coal from coal supply 12 and serves to grind the coal so as to reduce the size of the coal particles to an average sieve size in the range of between 20 meshes ($850 \times 10^{-6}\text{m}$ or 850 μm) and 80 meshes ($180 \times 10^{-6}\text{m}$ or 180 μm). The preferred size of the coal particles will be an average of 40 meshes ($425 \times 10^{-6}\text{m}$ or 425 μm).

Initially, a supply 16 of fresh hydrated lime [$\text{Ca}(\text{OH})_2$] is provided in powder form. The actual powder form of the fresh hydrated lime in the supply 16 is of a size which is less than 10% of the size of the coal particles from the grinder 14. The fresh hydrated lime will pass to a blender 18 along with the coal particles from the grinder 14. The fine particles of coal from the grinder 14 are thoroughly blended with a predetermined amount of the fresh hydrated lime. The amount of the hydrated lime [$\text{Ca}(\text{OH})_2$] to be added to the ground coal will depend upon the content, nature and distribution of sulfur in the coal. The amount of hydrated lime should range from between 1 to 15% of the weight of the coal. The preferred amount of hydrated lime which is added to the ground coal will be approximately 5% to 6% when the sulfur content of the coal is about 3%.

As can be seen in FIGURE 1, inlet 20 is provided so as to introduce water into the blender 18. An outlet 22 is provided so as to remove water from the blender 18. In order to allow for the intimate agglomeration between the particles of coal and the particles of hydrated lime to occur, the moisture content of the mixture must be maintained at an appropriate level. Accordingly, water is either added to or removed from the mixture in the blender 18 depending upon the moisture content of the coal. The moisture level of the resultant blended mixture should be within the range of between 10 and 30% on the basis of the overall weight. The preferred moisture level of the resultant mixture is approximately 25%. For example, the moisture content of the fresh coal may range from

a minimum of 15% to as high as 30% based upon the weight of the coal. If dried coal is used, then the moisture content may be as low as 1%. On the other hand, when the moisture content is below 10%, then it would be necessary to add water to the blender 18. As such, the inlet 20 and the outlet 22 are provided so as to add or remove water, respectively, as required relative to the moisture content of the coal.

The particles of hydrated lime $[\text{Ca}(\text{OH})_2]$ distribute themselves among the coal particles through thorough mixing. However, because of their bonding characteristics, they adhere firmly to the coal particles. The average size of the resultant particles is 10 to 20% greater than that of the coal particles.

The agglomerated particles are then passed from the blender 18 to the dryer 24. In the dryer, the coal/hydrated lime mixture is dried so as to have a final moisture content of approximately 1%. The dryer 24 is an externally heated dryer or oven which acts on the coal/hydrated lime mixture with a temperature of between 300 and 400°F. The preferred temperature is 350°F. Any source of heat can be provided to the dryer 24 so as to accomplish the drying of the coal. For example, one source of heat for the drying can be surplus or waste heat from a power plant. The broken line 26 illustrates how this waste heat can be passed to the dryer 24 from the power plant. Another method of drying is to utilize the dryer 24 in a preheater with the same source of surplus or waste heat prior to the injection of the coal/hydrated lime mixture into the combustion chamber 28. By recirculating the heat from the combustion chamber or from the boiler of the power plant, a great deal of savings in the cost of energy and facilities for the drying of the coal/hydrated lime mixture can be achieved.

The following test results show the improvement in sulfur emission through the use of the process of the present invention:

A. Composition and Heating Value
of the Original Sample
(Illinois Coal: Sample No. 1 BC-110)

<u>Component</u>	<u>Wt%</u>
Moisture	10.6
Volatile Matter	39.5
Fixed C	50.8
H-T Ash	9.7
Carbon	71.3
Hydrogen	5.2
Nitrogen	1.4
Sulfatic Sulfur	0.1
Pyritic Sulfur	2.1
Organic Sulfur	2.4
Total Sulfur	4.6
Total Chlorine	0.0
High Heating Value (HHV) (Moisture Free Basis)	13,077 Btu/lb

B. Reduction in Sulfur Emission and
High Heating Value (HHV)
Treated Coal (SULFACOAL)

<u>Content of Reagent (wt%)</u>	<u>HHV, Moisture Free Basis (Btu/lb)</u>	<u>Estimated Reduction in Sulfur Emission (%)</u>
5	12094	ca. 80% or more
7	11896	ca. 85% or more

As can be seen from these test results, the process of the present invention treats high-sulfur coal with the fresh hydrated lime $[\text{Ca}(\text{OH})_2]$ so that sulfur emission from the combustion of the coal can be reduced by up to 90%. Combustion of the treated coal generates less ash than that of untreated coal with sulfur-removal by a conventional lime (CaO) scrubbing system. The characteristics of the product of the process of the present invention are attributable to the fact that the fresh hydrated lime, yet to be exposed to carbon dioxide (CO_2) in the atmosphere to any

appreciable extent, is far more reactive with sulfur in coal than unhydrated lime (CaO). Moreover, the ash of the treated coal of the process of the present invention has a lower pH than ash from conventional combustion and is of good quality. As a result, it makes the ash ideal for marketing rather than disposal.

The process of the present invention uses waste heat of the power plant and can be operated by current operators. Thus, these operators can maintain their own quality control on the fuel source with no change in coal supply or contractors. The process is not affected by extreme winter conditions and is suitable for direct feed to the boilers, thereby circumventing the necessity of preheating. By using waste heat, the process of the present invention conserves valuable resources and reduces the impact on the environment.

According to the test results utilizing the process of the present invention, the process of the present invention only marginally reduces the heating value or BTU's of the treated coal. However, the results indicate that emissions fall well below U.S. E.P.A. limits. Consequently, this decreases the requirement for expensive, sulfur-scrubbing equipment. Furthermore, a power plant supplied with the treated coal of the present invention requires much smaller amounts of scrubbing agents than an equivalent conventional power plant with sulfur scrubbing facilities. As a result, there is a savings on the costs of bulk handling, storage and transportation.

In addition to the substantial reduction in costs and in sulfur emissions, the treated coal of the present invention has two other noteworthy benefits. First, there is a decrease in NO_x generation. Second, there is also a capture of heavy metals in the ash through the formation of metallic hydroxides with low solubilities. Moreover, the amount of ash from a power plant supplied with the treated coal of the present invention is an order of magnitude less than the amount of ash produced from an equivalent power plant utilizing lime injection.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof. Various changes in the details of the illustrated process can be made within the scope of the present invention without departing from the true spirit of the invention.

CLAIMS

WE CLAIM:

1. A method of manufacturing a coal product having reduced sulfur emissions comprising:
grinding a raw coal material into a coal powder having a desired particle size;
blending said coal powder with hydrated lime;
adding water to the blend of coal powder and hydrated lime so as to have a moisture content of between 10 and 30 weight percent of the total weight of the water-added blend; and
drying the water-added blend so as to have a desired moisture content.
2. The method of Claim 1, said coal powder having a particle size of between 80 and 20 meshes.
3. The method of Claim 2, said coal powder having an average particle size of 40 meshes.
4. The method of Claim 1, said raw coal material being a high-sulfur coal.
5. The method of Claim 1, said hydrated lime being of a particle form.
6. The method of Claim 5, said particle form of said hydrated lime having an average size of less than 10 percent of said desired particle size of said coal powder.

7. The method of Claim 1, said step of blending comprising:
mixing said hydrated lime with said coal powder in which said hydrated lime is 1 to 15 weight percent of the weight of said coal powder.
8. The method of Claim 1, said step of adding water comprising:
adding water to the blend so as to form an intimate agglomeration of said coal powder and said hydrated lime.
9. The method of Claim 1, said desired moisture content being less than 1 weight percent.
10. The method of Claim 1, said step of drying comprising:
passing the water-added blend to an externally heated oven.
11. The method of Claim 10, said step of drying further comprising:
heating the water-added blend to a temperature of between 300 and 400°F.
12. The method of Claim 11, said step of heating comprising:
heating the water-added blend from waste heat from a power plant.
13. The method of Claim 10, said step of drying further comprising:
preheating the water-added blend prior to passing the water-added blend into said externally heated oven.
14. The method of Claim 1, the raw coal material having a sulfur content of approximately 3% of a total weight of the raw coal material, said hydrated lime being between 5 to 6 weight percent of the total weight of the raw coal material.

15. A method of manufacturing a coal product having reduced sulfur emissions comprising:
grinding coal into a powder having a particle size of between 80 and 20 meshes;
blending the powder with hydrated lime in which the hydrated lime is between 1 to 15 weight percent of the weight of the powder;
adding water to the blend so that the blend has a moisture content of between 10 and 30 weight percent of the total weight of the blend; and
heating the water-added blend to a temperature of between 300 and 400°F so as to dry the blend to a moisture content of less than 1 weight percent.

15. The method of Claim 14, said coal having a sulfur content of no less than 3 weight percent of the total weight of the coal.

16. The method of Claim 14, said hydrated lime being between 5 to 6 weight percent of the total weight of the powder.

17. The method of Claim 15, said step of heating comprising:
passing the blend to an externally heated oven.

18. The method of Claim 17, said step of heating further comprising:
preheating the blend prior to passing the blend to said externally heated oven.

19. The method of Claim 15, said step of adding water comprising:
intimately agglomerating the coal and the hydrated lime.

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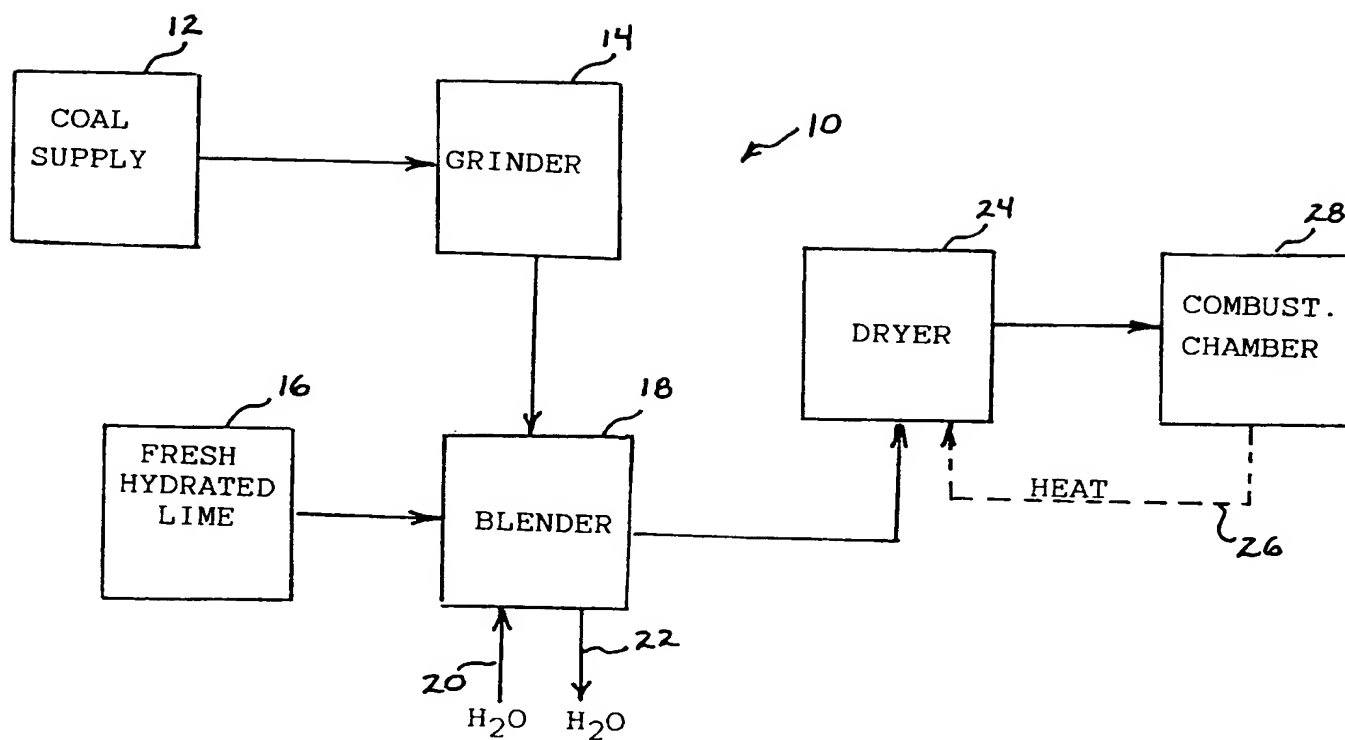


FIG. 1

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US00/27357

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : C10L 9/10

US CL : 44/ 604, 503, 504

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 44/ 604, 503, 504

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,226,601 A (SMITH) 07 October 1980, see entire document.	1-19
Y	US 4,522,626 A (ESPENSCHIED) 11 June 1985, see entire document.	1-19
A	US 4,824,441 A (KINDIG) 25 April 1989, see entire document.	1-19

☐

Further documents are listed in the continuation of Box C.

☐

See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T"

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X"

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y"

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"

document member of the same patent family

Date of the actual completion of the international search

13 November 2000 (13.11.2000)

Date of mailing of the international search report

29 DEC 2000

Name and mailing address of the ISA/US

Commissioner of Patents and Trademarks

Box PCT

Washington, D.C. 20231

Facsimile No. (703)305-3230

Authorized officer

Jerry D. Johnson

Telephone No. (703) 308-0661

Jean Proctor
Paralegal Specialist

RELATED U.S. APPLICATIONS

Not applicable.

STATEMENT REGARDING FEDERALLY SPONSORED
RESEARCH OR DEVELOPMENT

Not applicable.

REFERENCE TO MICROFICHE APPENDIX

Not applicable.

FIELD OF THE INVENTION

[0001] The present invention relates to coal desulfurization. More particularly, the present invention relates to methods and processes by which the resultant emissions of sulfur from coal burning operations are reduced. The present invention also relates to the manufacture of coal treated with fresh hydrated lime.

BACKGROUND OF THE INVENTION

[0002] Electric-power plants fired by coal or oil emit sulfur oxides, nitrogen oxides, and particulates. In industrialized countries, such plants account for up to 75% of the total of sulfur oxides, and, since the electric-power industry is rapidly proliferating, the potential increase of sulfur-oxide emissions is tremendous.

[0003] A number of measures have been adopted in an effort to control sulfur-oxide pollution. However, a number of technical problems stand in the way. In many existing power plants, low-sulfur

coal cannot be burned without operational difficulties or without incurring high capital costs for furnace modifications. Sulfur can be removed from coal before burning, but the procedure is costly. The content can be cut in half by pulverizing the coal to the consistency of talcum powder and removing the pyrites (sulfur compounds) or by one-third by washing the coal and removing noncarbonaceous material. However, even with as much as 70% of the sulfur removed, the final coal product might still be classified as a high-sulfur fuel.

[0004] Several methods of removing sulfur from stack gases have been considered and utilized. In one technique, pulverized limestone or dolomite is added to the boiler charge, creating oxides that react with the sulfur oxides to form solid sulfite and sulfate particles that can be removed by electrostatic precipitation. In another process, catalytic conversion, the sulfur dioxide is converted to sulfur trioxide, which combines with water in the stack gas to form a sulfuric acid mist that can be trapped and eliminated. Another method is to produce sulfuric acid, which can be readily removed from the stack gas by the addition of an activated char, a carbonaceous material.

[0005] In most uses, the sulfur content of coal is objectionable in varying degrees. Part of the sulfur is associated with ash, and coal washing removes some sulfur along with the ash. Much sulfur, however, is more intimately associated with the coal substance itself and cannot be removed by washing. Since carbonization removes some sulfur, coke usually contains a lower percentage of sulfur than the coal from which it is made. During total gasification, most of the sulfur is converted into hydrogen sulfide, the form in which it can be readily separated from the gas. Extraction of coal with solvents produces an extract of relatively low sulfur content. Despite the use of these methods and considerable effort, no effective method has been devised to reduce the sulfur content substantially, particularly the portion closely associated with the coal substance.

[0006] It is an object of the present invention to reduce sulfur emissions from the combustion of high-sulfur coal.

[0007] It is a further object of the present invention to provide a process that reduces the ash from the combusted coal.

[0008] It is a further object of the present invention to provide a process that lowers the pH of the ash of the combusted coal.

[0009] It is still a further object of the present invention to provide a process for reducing sulfur emissions in an economic, efficient and easy-to-use operation.

[0010] These and other objects and advantages of the present invention will become apparent from a reading of the attached specification.

BRIEF SUMMARY OF THE INVENTION

[0011] The present invention is a process for manufacturing modified coal so as to reduce sulfur emissions. This process comprises the steps of: (1) grinding the coal to a powder of a desired consistency and particle size; (2) blending the ground coal with fresh hydrated lime $[\text{Ca}(\text{OH})_2]$; (3) adding water to the blended coal/hydrated lime mixture so as to maintain a moisture content of between 10 and 30% of the overall weight; and (4) drying the agglomerated coal/hydrated lime mixture so as to have a moisture content of a desired level.

[0012] In the process of the present invention, the coal is ground to a size of between 80 and 20 meshes (180 micrometers to 850 micrometers). Ideally, the average size of the ground coal particle will be 40 meshes (425 micrometers). Within the concept of the present invention, the coal which is ground is a high-sulfur coal. The fresh hydrated lime is in a powder form. Ideally, the particles of the powder form of the hydrated lime should be less than 10% of the size of the coal particles. The amount of hydrated

lime which is added to the ground coal particles will depend upon sulfur content of the coal.

Generally, the amount of fresh hydrated lime will be 1 to 15% of the weight of the coal.

[0013] Water is added to the blended mixture of the hydrated lime and ground coal so as to achieve an intimate agglomeration. Finally, the agglomeration is dried so that the moisture content is approximately 1%. The drying can be accomplished by using externally heated dryers or ovens. The mixture of the water, hydrated lime, and ground coal is heated to a temperature of between 300 and 400°F. The heat for such dryers can be provided by the waste heat of a power plant. The heat can also be provided by a preheater prior to passing the treated coal to the boiler.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0014] FIGURE 1 is a schematic illustration of the process of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0015] Referring to FIGURE 1, there is shown at 10 a schematic representation of the process of the present invention. In the present invention, a coal supply 12 is available for the delivery of coal to a grinder 14. The coal supply 12 can be of a high-sulfur coal. The grinder receives the high-sulfur coal from coal supply 12 and serves to grind the coal so as to reduce the size of the coal particles to an average sieve size in the range of between 20 meshes ($850 \times 10^{-6}\text{m}$ or 850 μm) and 80 meshes ($180 \times 10^{-6}\text{m}$ or 180 μm). The preferred size of the coal particles will be an average of 40 meshes ($425 \times 10^{-6}\text{m}$ or 425 μm).

[0016] Initially, a supply 16 of fresh hydrated lime $[\text{Ca}(\text{OH})_2]$ is provided in powder form. The actual powder form of the fresh hydrated lime in the supply 16 is of a size which is less than 10% of the size of the coal particles from the grinder 14. The fresh hydrated lime will pass to a blender 18 along with

the coal particles from the gr 14. The fine particles of coal from grinder 14 are thoroughly blended with a predetermined amount of the fresh hydrated lime. The amount of the hydrated lime $[\text{Ca}(\text{OH})_2]$ to be added to the ground coal will depend upon the content, nature and distribution of sulfur in the coal. The amount of hydrated lime should range from between 1 to 15% of the weight of the coal. The preferred amount of hydrated lime which is added to the ground coal will be approximately 5% to 6% when the sulfur content of the coal is about 3%.

[0017] As can be seen in FIGURE 1, inlet 20 is provided so as to introduce water into the blender 18. An outlet 22 is provided so as to remove water from the blender 18. In order to allow for the intimate agglomeration between the particles of coal and the particles of hydrated lime to occur, the moisture content of the mixture must be maintained at an appropriate level. Accordingly, water is either added to or removed from the mixture in the blender 18 depending upon the moisture content of the coal. The moisture level of the resultant blended mixture should be within the range of between 10 and 30% on the basis of the overall weight. The preferred moisture level of the resultant mixture is approximately 25%. For example, the moisture content of the fresh coal may range from a minimum of 15% to as high as 30% based upon the weight of the coal. If dried coal is used, then the moisture content may be as low as 1%. On the other hand, when the moisture content is below 10%, then it would be necessary to add water to the blender 18. As such, the inlet 20 and the outlet 22 are provided so as to add or remove water, respectively, as required relative to the moisture content of the coal.

[0018] The particles of hydrated lime $[\text{Ca}(\text{OH})_2]$ distribute themselves among the coal particles through thorough mixing. However, because of their bonding characteristics, they adhere firmly to the coal particles. The average size of the resultant particles is 10 to 20% greater than that of the coal particles.

[0019] The agglomerated particles are then passed from the blender 18 to the dryer 24. In the dryer, the coal/hydrated lime mixture is dried so as to have a final moisture content of approximately 1%. The

dryer 24 is an externally heated dryer or oven which acts on the coal hydrated lime mixture with a temperature of between 300 and 400°F. The preferred temperature is 350°F. Any source of heat can be provided to the dryer 24 so as to accomplish the drying of the coal. For example, one source of heat for the drying can be surplus or waste heat from a power plant. The broken line 26 illustrates how this waste heat can be passed to the dryer 24 from the power plant. Another method of drying is to utilize the dryer 24 in a preheater with the same source of surplus or waste heat prior to the injection of the coal/hydrated lime mixture into the combustion chamber 28. By recirculating the heat from the combustion chamber or from the boiler of the power plant, a great deal of savings in the cost of energy and facilities for the drying of the coal/hydrated lime mixture can be achieved.

[0020] The following test results show the improvement in sulfur emission through the use of the process of the present invention:

A. Composition and Heating Value
of the Original Sample
(Illinois Coal: Sample No. 1 BC-110)

<u>Component</u>	<u>Wt%</u>
Moisture	10.6
Volatile Matter	39.5
Fixed C	50.8
H-T Ash	9.7
Carbon	71.3
Hydrogen	5.2
Nitrogen	1.4
Sulfatic Sulfur	0.1
Pyritic Sulfur	2.1
Organic Sulfur	2.4
Total Sulfur	4.6
Total Chlorine	0.0
High Heating Value (HHV) (Moisture Free Basis)	13,077 Btu/lb

Reduction in Sulfur Emission and
High Heating Value (HHV)
Treated Coal (SULFACOAL)

<u>Content of Reagent (wt%)</u>	<u>HHV, Moisture Free Basis (Btu/lb)</u>	<u>Estimated Reduction in Sulfur Emission (%)</u>
5	12094	ca. 80% or more
7	11896	ca. 85% or more

[0021] As can be seen from these test results, the process of the present invention treats high-sulfur coal with the fresh hydrated lime $[\text{Ca}(\text{OH})_2]$ so that sulfur emission from the combustion of the coal can be reduced by up to 90%. Combustion of the treated coal generates less ash than that of untreated coal with sulfur-removal by a conventional lime (CaO) scrubbing system. The characteristics of the product of the process of the present invention are attributable to the fact that the fresh hydrated lime, yet to be exposed to carbon dioxide (CO_2) in the atmosphere to any appreciable extent, is far more reactive with sulfur in coal than unhydrated lime (CaO). Moreover, the ash of the treated coal of the process of the present invention has a lower pH than ash from conventional combustion and is of good quality. As a result, it makes the ash ideal for marketing rather than disposal.

[0022] The process of the present invention uses waste heat of the power plant and can be operated by current operators. Thus, these operators can maintain their own quality control on the fuel source with no change in coal supply or contractors. The process is not affected by extreme winter conditions and is suitable for direct feed to the boilers, thereby circumventing the necessity of preheating. By using waste heat, the process of the present invention conserves valuable resources and reduces the impact on the environment.

[0023] According to the test results utilizing the process of the present invention, the process of the present invention only marginally reduces the heating value or BTU's of the treated coal. However, the

results indicate that emissions are well below U.S. E.P.A. limits. Consequently, this decreases the requirement for expensive, sulfur-scrubbing equipment. Furthermore, a power plant supplied with the treated coal of the present invention requires much smaller amounts of scrubbing agents than an equivalent conventional power plant with sulfur scrubbing facilities. As a result, there is a savings on the costs of bulk handling, storage and transportation.

[0024] In addition to the substantial reduction in costs and in sulfur emissions, the treated coal of the present invention has two other noteworthy benefits. First, there is a decrease in NO_x generation. Second, there is also a capture of heavy metals in the ash through the formation of metallic hydroxides with low solubilities. Moreover, the amount of ash from a power plant supplied with the treated coal of the present invention is an order of magnitude less than the amount of ash produced from an equivalent power plant utilizing lime injection.

[0025] The foregoing disclosure and description of the invention is illustrative and explanatory thereof. Various changes in the details of the illustrated process can be made within the scope of the present invention without departing from the true spirit of the invention.

CLAIMS

We claim:

1. A method of manufacturing a coal product having reduced sulfur emissions comprising:
 - grinding a raw coal material into a coal powder having a desired particle size;
 - blending said coal powder with hydrated lime;
 - adding water to the blend of coal powder and hydrated lime so as to have a moisture content of between 10 and 30 weight percent of the total weight of the water-added blend; and
 - drying the water-added blend so as to have a desired moisture content.
2. The method of Claim 1, said coal powder having a particle size of between 80 and 20 meshes.
3. The method of Claim 2, said coal powder having an average particle size of 40 meshes.
4. The method of Claim 1, said raw coal material being a high-sulfur coal.
5. The method of Claim 1, said hydrated lime being of a particle form.
6. The method of Claim 5, said particle form of said hydrated lime having an average size of less than 10 percent of said desired particle size of said coal powder.
7. The method of Claim 1, said step of blending comprising:
 - mixing said hydrated lime with said coal powder in which said hydrated lime is 1 to 15 weight percent of the weight of said coal powder.

8. The method of Claim 1, said step of adding water comprising:

adding water to the blend so as to form an intimate agglomeration of said coal powder and said hydrated lime.

9. The method of Claim 1, said desired moisture content being less than 1 weight percent.

10. The method of Claim 1, said step of drying comprising:

passing the water-added blend to an externally heated oven.

11. The method of Claim 10, said step of drying further comprising:

heating the water-added blend to a temperature of between 300 and 400°F.

12. The method of Claim 11, said step of heating comprising:

heating the water-added blend from waste heat from a power plant.

13. The method of Claim 10, said step of drying further comprising:

preheating the water-added blend prior to passing the water-added blend into said externally heated oven.

14. The method of Claim 1, the raw coal material having a sulfur content of approximately 3% of a total weight of the raw coal material, said hydrated lime being between 5 to 6 weight percent of the total weight of the raw coal material.

15. A method of manufacturing a coal product having reduced sulfur emissions comprising:
- grinding coal into a powder having a particle size of between 80 and 20 meshes;
 - blending the powder with hydrated lime in which the hydrated lime is between 1 to 15 weight percent of the weight of the powder;
 - adding water to the blend so that the blend has a moisture content of between 10 and 30 weight percent of the total weight of the blend; and
 - heating the water-added blend to a temperature of between 300 and 400°F so as to dry the blend to a moisture content of less than 1 weight percent.
16. The method of Claim 15, said coal having a sulfur content of no less than 3 weight percent of the total weight of the coal.
17. The method of Claim 15, said hydrated lime being between 5 to 6 weight percent of the total weight of the powder.
18. The method of Claim 15, said step of heating comprising:
- passing the blend to an externally heated oven.
19. The method of Claim 18, said step of heating further comprising:
- preheating the blend prior to passing the blend to said externally heated oven.
20. The method of Claim 15, said step of adding water comprising:
- intimately agglomerating the coal and the hydrated lime.

 ABSTRACT OF THE DISCLOSURE

A method of manufacturing a coal product having reduced sulfur emissions including the steps of grinding coal into a powder form having a desired particle size; blending the ground coal with hydrated lime; adding water to the blend so as to have a moisture content of between 10 and 30 weight percent and drying the water-added blend so as to have a desired reduced moisture content. The desired reduced moisture content is less than 1 % of the total weight of the coal powder and the hydrated lime;. The step of drying includes heating the water-added blend to a temperature of between 300 and 400°F in an externally heated oven. Waste heat from a power plant can be used so as to heat the blend.

PATENT COOPERATION TREATY

PCT

REC'D 26 MAR 2002

WIPO PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

6

Applicant's or agent's file reference 656,095		FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/US00/27357	International filing date (day/month/year) 04 October 2000 (04.10.2000)	Priority date (day/month/year) 05 October 1999 (05.10.1999)	
International Patent Classification (IPC) or national classification and IPC IPC(7): C10L 9/10 and US Cl.: 44/ 604, 503, 504			
Applicant ROBIN B. SOMERVILLE			
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of <u>3</u> sheets, including this cover sheet.</p> <p><input type="checkbox"/> This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of <u>0</u> sheets.</p>			
<p>3. This report contains indications relating to the following items:</p> <p>I <input checked="" type="checkbox"/> Basis of the report</p> <p>II <input type="checkbox"/> Priority</p> <p>III <input type="checkbox"/> Non-establishment of report with regard to novelty, inventive step and industrial applicability</p> <p>IV <input type="checkbox"/> Lack of unity of invention</p> <p>V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p>VI <input type="checkbox"/> Certain documents cited</p> <p>VII <input type="checkbox"/> Certain defects in the international application</p> <p>VIII <input type="checkbox"/> Certain observations on the international application</p>			
Date of submission of the demand 16 April 2001 (16.04.2001)		Date of completion of this report 12 March 2002 (12.03.2002)	
Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230		Authorized officer Jerry D. Johnson Jean Proctor Paralegal Specialist Telephone No. (703) 308-0661	

I. Basis of the report**1. With regard to the elements of the international application:***

- ☒ the international application as originally filed.
- ☒ the description:
pages 1-6 as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of _____.
- ☒ the claims:
pages 7-9, as originally filed
pages NONE, as amended (together with any statement) under Article 19
pages NONE, filed with the demand
pages NONE, filed with the letter of _____.
- ☒ the drawings:
pages 1, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of _____.
- ☐ the sequence listing part of the description:
pages NONE, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of _____.

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language _____ which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in printed form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages NONE
- ☐ the claims, Nos. NONE
- ☐ the drawings, sheets/fig NONE

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US00/273**V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. STATEMENT**

Novelty (N)	Claims <u>1-19</u>	YES
	Claims <u>NONE</u>	NO
Inventive Step (IS)	Claims <u>NONE</u>	YES
	Claims <u>1-19</u>	NO
Industrial Applicability (IA)	Claims <u>1-19</u>	YES
	Claims <u>NONE</u>	NO

2. CITATIONS AND EXPLANATIONS

Claims 1-19 lack an inventive step under PCT Article 33(3) as being obvious over Smith.

Smith, U.S. Patent 4,226,601, teaches a process for preparing a coal or lignite fuel, which contains sulfur, for combustion (col. 1, lines 16-18). Sulfur-containing coal or lignite is reduced in size to form a finely divided coal or lignite. The thus pulverized sulfur-containing coal or lignite is then admixed with a finely divided inorganic material (col. 2, lines 41-43). The inorganic material can be, *inter alia*, a hydroxide of calcium (col. 2, lines 50-56). It has been found that as the particle size of the coal or lignite decreases, the efficiency of the invention in reducing the emissions of sulfur containing air contaminants increases. Thus there is no minimum size restriction placed on the particle size of the coal or lignite (col. 3, lines 14-22). When the inorganic materials are added to the coal or lignite in an aqueous or slurry form, substantially all of the solvent or liquid carrier should be evaporated or otherwise removed from the admixture to leave a substantially dry admixture for burning (col. 4, lines 2-6). The inorganic materials should have a particle size in the general range of the particle sizes for the sulfur containing coal or lignite (col. 4, lines 14-17). The pulverized coal or lignite and the finely divided inorganic materials can be intimately admixed together by any suitable means (col. 4, lines 31-33). The amount of inorganic material that will be added to and admixed with the pulverized coal or lignite will depend on the amount of sulfur that is contained in the raw coal or lignite (col. 5, lines 59-62). While Smith does not teach the addition of water after blending the coal and inorganic material or the specifically recited numerical values (e.g., temperature or particle size), it would have been obvious to one having ordinary skill in the art to follow the above teachings and arrive at the instantly claimed invention based on optimization of the various process steps.

Claims 1-19 meet the criteria for industrial applicability as defined by PCT Article 33(4) because the claimed method produces a coal product having reduced sulfur emissions upon combustion.

----- NEW CITATIONS -----□

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
PCT RECEIVING OFFICE

APPLICANT: SOMERVILLE, Robin B.; FAN, Liang-Tseng

INTERNATIONAL FILING DATE: 04 October 2000

INTERNATIONAL APPLICATION NO.: PCT/US00/27357

TITLE: PROCESS FOR MODIFYING COAL SO AS TO REDUCE SULFUR EMISSIONS

REPLY TO THE INVITATION TO CORRECT DEFECTS AND
RESPONSE TO COMMUNICATION FOR WHICH NO OTHER FORM IS APPLICABLE

Commissioner of Patents
and Trademarks
Box PCT
Washington, D.C. 20231
Attention: RO/US

Sirs:

In reply to the Invitation to Correct Defects in the International Application dated October 30, 2000, a response being due by November 30, 2000, and in reply to the Communication in Cases for which no Other Form is Applicable in the International Application dated October 30, 2000, Applicant is enclosing herewith replacement sheets for the original Specification, Claims and drawings and presents the following remarks.

REMARKS

In Annex B1, the Invitation to Correct Defects, dated October 30, 2000, states that the minimum top margin on the first page is not adequate. The Invitation requests a new first page. Applicant has provided a replacement page in compliance with the margins set for the top margin of the first page.

In Annex C1, the Invitation to Correct Defects states that the minimum left margin on the first page of the drawings is not adequate. The Invitation requests a new first page of the drawings. Applicant has provided a replacement page in compliance with the margins set for the left margin of the first page of drawings.


The Communication in Cases for which no Other Form is Applicable, dated October 30, 2000, states that Claim 15 has been numbered twice. The Communication does not specify a date for reply and does not provide a suggestion for correcting the defect. In reply, Applicant has provided a replacement page to correct the numbering of the claims.

Applicant respectfully contends that, upon entry of the replacement pages of the specification and claims and entry of the replacement pages of the drawings, the application will comply with format requirements.

Thus, Applicant respectfully contends that the present International Application is now in a proper format.

Respectfully submitted,

11-14-00
Date



John S. Egbert
Reg. No. 30,627
Attorney for Applicant

Harrison & Egbert
1018 Preston, Suite 100
Houston, Texas 77002
(713)223-4034
(713)223-4873 (Fax)

PROCESS FOR MODIFYING COAL SO AS TO REDUCE SULFUR EMISSIONS

TECHNICAL FIELD

The present invention relates to coal desulfurization. More particularly, the present invention relates to methods and processes by which the resultant emissions of sulfur from coal burning operations are reduced. The present invention also relates to the manufacture of coal treated with fresh hydrated lime.

BACKGROUND ART

Electric-power plants fired by coal or oil emit sulfur oxides, nitrogen oxides, and particulates. In industrialized countries, such plants account for up to 75% of the total of sulfur oxides, and, since the electric-power industry is rapidly proliferating, the potential increase of sulfur-oxide emissions is tremendous.

A number of measures have been adopted in an effort to control sulfur-oxide pollution. However, a number of technical problems stand in the way. In many existing power plants, low-sulfur coal cannot be burned without operational difficulties or without incurring high capital costs for furnace modifications. Sulfur can be removed from coal before burning, but the procedure is costly. The content can be cut in half by pulverizing the coal to the consistency of talcum powder and removing the pyrites (sulfur compounds) or by one-third by washing the coal and removing noncarbonaceous material. However, even with as much as 70% of the sulfur removed, the final coal product might still be classified as a high-sulfur fuel.

Several methods of removing sulfur from stack gases have been considered and utilized. In one technique, pulverized limestone or dolomite is added to the boiler charge, creating oxides that react with the sulfur oxides to form solid sulfite and sulfate particles that can be removed by electrostatic precipitation. In another process, catalytic conversion, the sulfur dioxide is converted to sulfur trioxide, which combines with water in the stack gas to form a sulfuric acid mist that can be trapped and eliminated. Another method is to produce sulfuric acid, which can be readily removed from the stack gas by the addition of an activated char, a carbonaceous material.

In most uses, the sulfur content of coal is objectionable in varying degrees. Part of the sulfur is associated with ash, and coal washing removes some sulfur along with the ash. Much sulfur, however, is more intimately associated with the coal substance itself and cannot be removed by washing. Since carbonization removes some sulfur, coke usually contains a lower percentage of sulfur than the coal from which it is made. During total gasification, most of the sulfur is converted into hydrogen sulfide, the form in which it can be readily separated from the gas. Extraction of coal

1/1

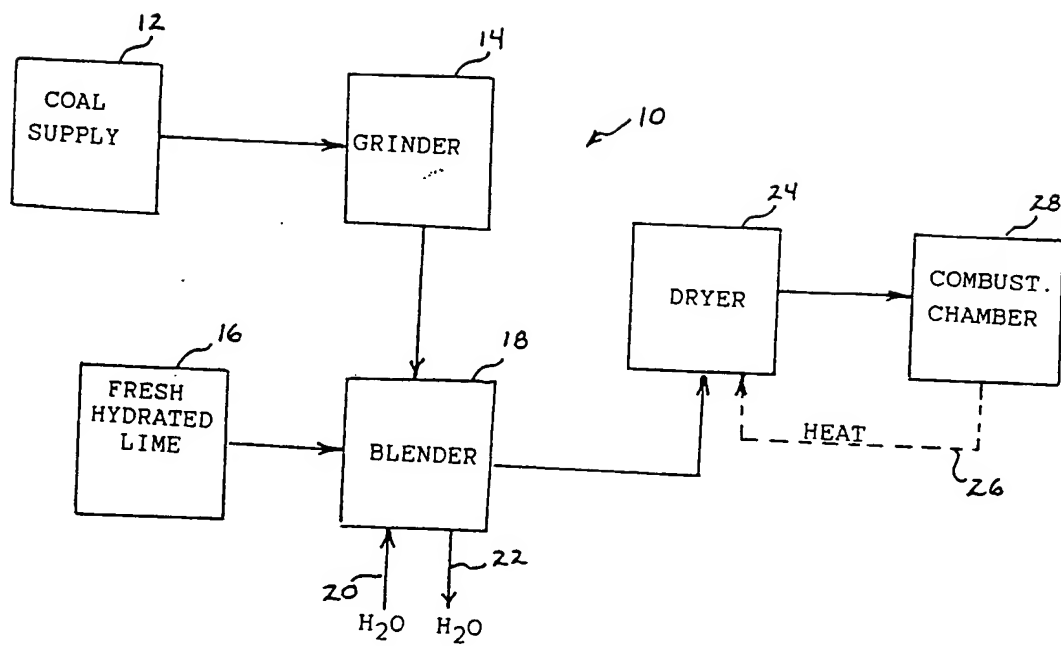


FIG. 1

15. A method of manufacturing a coal product having reduced sulfur emissions comprising:

grinding coal into a powder having a particle size of between 80 and 20 meshes;

blending the powder with hydrated lime in which the hydrated lime is between 1 to 15 weight percent of the weight of the powder;

adding water to the blend so that the blend has a moisture content of between 10 and 30 weight percent of the total weight of the blend; and

heating the water-added blend to a temperature of between 300 and 400° F so as to dry the blend to a moisture content of less than 1 weight percent.

16. The method of Claim 15, said coal having sulfur content of no less than 3 weight percent of the total weight of the coal.

17. The method of Claim 15, said hydrated lime being between 5 to 6 weight percent of the total weight of the powder.

18. The method of Claim 15, said step of heating comprising:

passing the blend to an externally heated oven.

19. The method of Claim 18, said step of heating further comprising:

preheating the blend prior to passing the blend to said externally heated oven.

20. The method of Claim 15, said step of adding water comprising:

intimately agglomerating the coal and the hydrated lime.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US00/27357

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : C10L 9/10
US CL : 44/ 604, 503, 504

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 44/ 604, 503, 504

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,226,601 A (SMITH) 07 October 1980, see entire document.	1-19
Y	US 4,522,626 A (ESPENSCHIED) 11 June 1985, see entire document.	1-19
A	US 4,824,441 A (KINDIG) 25 April 1989, see entire document.	1-19

☐ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T"

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X"

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y"

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"

document member of the same patent family

Date of the actual completion of the international search

13 November 2000 (13.11.2000)

Date of mailing of the international search report

29 DEC 2000

Name and mailing address of the ISA/US

Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703)305-3230

Authorized officer

Jerry D. Johnson

Telephone No. (703) 308-0661

Jean Proctor
Paralegal Specialist

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:
JOHN S. EGBERT
HARRISON & EGBERT
412 MAIN STREET
7TH FLOOR
HOUSTON, TX 77002

PCT

NOTIFICATION OF TRANSMITTAL OF INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of Mailing
(day/month/year)

21 MAR 2002

Applicant's or agent's file reference

656,095

IMPORTANT NOTIFICATION

International application No.

PCT/US00/27357

International filing date (day/month/year)

04 October 2000 (04.10.2000)

Priority date (day/month/year)

05 October 1999 (05.10.1999)

Applicant

ROBIN B. SOMERVILLE

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.
2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.
3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.
4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices)(Article 39(1))(see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/US

Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703)305-3230

Authorized officer

Jerry D. Johnson

Jean Proctor
Paralegal Specialist

Telephone No. (703) 308-0661

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 656,095	FOR FURTHER ACTION		See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/US00/27357	International filing date (<i>day/month/year</i>) 04 October 2000 (04.10.2000)	Priority date (<i>day/month/year</i>) 05 October 1999 (05.10.1999)	
International Patent Classification (IPC) or national classification and IPC IPC(7): C10L 9/10 and US Cl.: 44/ 604, 503, 504			
Applicant ROBIN B. SOMERVILLE			
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of <u>3</u> sheets, including this cover sheet.</p> <p><input type="checkbox"/> This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of <u>0</u> sheets.</p>			
<p>3. This report contains indications relating to the following items:</p> <ul style="list-style-type: none"> I <input checked="" type="checkbox"/> Basis of the report II <input type="checkbox"/> Priority III <input type="checkbox"/> Non-establishment of report with regard to novelty, inventive step and industrial applicability IV <input type="checkbox"/> Lack of unity of invention V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement VI <input type="checkbox"/> Certain documents cited VII <input type="checkbox"/> Certain defects in the international application VIII <input type="checkbox"/> Certain observations on the international application 			
Date of submission of the demand 16 April 2001 (16.04.2001)		Date of completion of this report 12 March 2002 (12.03.2002)	
Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230		Authorized officer Jerry D. Johnson Telephone No. (703) 308-0661 <div style="text-align: right;">Jean Proctor Paralegal Specialist</div>	

I. Basis of the report**1. With regard to the elements of the international application:***

- ☒ the international application as originally filed.
- ☒ the description:
pages 1-6 _____ as originally filed
pages NONE _____, filed with the demand
pages NONE _____, filed with the letter of _____.
- ☒ the claims:
pages 7-9 _____, as originally filed
pages NONE _____, as amended (together with any statement) under Article 19
pages NONE _____, filed with the demand
pages NONE _____, filed with the letter of _____.
- ☒ the drawings:
pages 1 _____, as originally filed
pages NONE _____, filed with the demand
pages NONE _____, filed with the letter of _____.
- ☐ the sequence listing part of the description:
pages NONE _____, as originally filed
pages NONE _____, filed with the demand
pages NONE _____, filed with the letter of _____.

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language _____ which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in printed form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages NONE
- ☐ the claims, Nos. NONE
- ☐ the drawings, sheets/fig NONE

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**1. STATEMENT**

Novelty (N)	Claims <u>1-19</u>	YES
	Claims <u>NONE</u>	NO
Inventive Step (IS)	Claims <u>NONE</u>	YES
	Claims <u>1-19</u>	NO
Industrial Applicability (IA)	Claims <u>1-19</u>	YES
	Claims <u>NONE</u>	NO

2. CITATIONS AND EXPLANATIONS

Claims 1-19 lack an inventive step under PCT Article 33(3) as being obvious over Smith.

Smith, U.S. Patent 4,226,601, teaches a process for preparing a coal or lignite fuel, which contains sulfur, for combustion (col. 1, lines 16-18). Sulfur-containing coal or lignite is reduced in size to form a finely divided coal or lignite. The thus pulverized sulfur-containing coal or lignite is then admixed with a finely divided inorganic material (col. 2, lines 41-43). The inorganic material can be, *inter alia*, a hydroxide of calcium (col. 2, lines 50-56). It has been found that as the particle size of the coal or lignite decreases, the efficiency of the invention in reducing the emissions of sulfur containing air contaminants increases. Thus there is no minimum size restriction placed on the particle size of the coal or lignite (col. 3, lines 14-22). When the inorganic materials are added to the coal or lignite in an aqueous or slurry form, substantially all of the solvent or liquid carrier should be evaporated or otherwise removed from the admixture to leave a substantially dry admixture for burning (col. 4, lines 2-6). The inorganic materials should have a particle size in the general range of the particle sizes for the sulfur containing coal or lignite (col. 4, lines 14-17). The pulverized coal or lignite and the finely divided inorganic materials can be intimately admixed together by any suitable means (col. 4, lines 31-33). The amount of inorganic material that will be added to and admixed with the pulverized coal or lignite will depend on the amount of sulfur that is contained in the raw coal or lignite (col. 5, lines 59-62). While Smith does not teach the addition of water after blending the coal and inorganic material or the specifically recited numerical values (e.g., temperature or particle size), it would have been obvious to one having ordinary skill in the art to follow the above teachings and arrive at the instantly claimed invention based on optimization of the various process steps.

Claims 1-19 meet the criteria for industrial applicability as defined by PCT Article 33(4) because the claimed method produces a coal product having reduced sulfur emissions upon combustion.

----- NEW CITATIONS -----□